

Assurance Issues for the Use of Optoelectronics in NASA Systems

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Abstract

With the rapidly increasing insertion of photonic devices, circuits and subsystems into NASA spacecraft, a variety of issues associated with radiation hardness assurance (RHA) have arisen. For example, the TOPEX/Poseidon (T/P) satellite uses optocouplers in various thruster circuits, and some of these couplers have been observed to fail after approximately two years in orbit. Subsequent ground testing using proton bombardment demonstrated that these failures were caused by displacement damage effects in the LEDs and phototransistors making up the optocouplers. In another in-flight occurrence, frequent malfunctions in upgraded electronics were observed in the Hubble Space Telescope due to short-duration transients from high-speed optocouplers in the retro-fitted new electronics package. These upsets were correlated with the higher proton flux that occurred when Hubble passed through the South Atlantic anomaly, and are most likely due to transients produced in the optocouplers when they are exposed to protons. Subsequent radiation testing at JPL and GSFC, in addition to flight experiments, confirmed that protons are responsible for these transient photocurrent events. In an additional example, the development and insertion of advanced optoelectronic devices in the Europa Orbiter presents difficult challenges because of the high radiation requirement for the Europa Orbiter mission. In this paper, we discuss these issues from the perspective of the radiation effects and hardening technology implications that are unique to optoelectronics.